

## CLAIMS

1. A manufacturing method comprising:
  - (1) obtaining a first integrated circuit structure comprising:  
a semiconductor substrate;  
5 one or more first conductive contact pads protruding out at a surface of the first integrated circuit structure;
  - (2) obtaining a first substrate comprising a circuit which comprises one or more first conductive contact pads, wherein at least a portion of each of the one or more first contact pads of the first substrate is located in a corresponding via in a surface of the first  
10 substrate;
  - (3) inserting the protruding first contact pads of the first integrated circuit structure into the corresponding vias of the first substrate and attaching the protruding first contact pads of the first integrated circuit structure to the first contact pads of the first substrate.
- 15 2. The method of Claim 1 wherein the operation (3) is performed without melting the protruding first contact pads of the first integrated circuit structure.
3. The method of Claim 2 wherein in the operation (3) the first contact pads of the first integrated circuit structure are soldered to the first contact pads of the first substrate.
- 20 4. The method of Claim 1 wherein an outer protruding surface of the first contact pads of the first integrated circuit structure is made of copper and/or gold and/or nickel.
5. The method of Claim 1 wherein the first substrate comprises a semiconductor substrate.
- 25 6. The method of Claim 1 wherein the first substrate is an integrated circuit packaging substrate which does not comprise a semiconductor substrate.

7. The method of Claim 1 wherein the first substrate is a printed circuit board.

8. The method of Claim 1 wherein in the operation (3) the attachment is performed without solder with thermal or thermosonic compression.

5 9. The method of Claim 1 wherein after the operation (3) a spacing between the bottom surface of the semiconductor substrate and the top surface of the first substrate is at least 5 $\mu$ m.

10 10. The method of Claim 1 wherein at least a portion of the bottom surface of the semiconductor substrate is not covered by any dielectric layer in the first integrated circuit structure.

11. The method of Claim 1 wherein at least a portion of the bottom surface of the semiconductor substrate is covered by a dielectric in the first integrated circuit structure.

15 12. The method of Claim 1 wherein in the operation (3) at least 10 $\mu$ m of each protruding first contact pad is inside the corresponding via.

13. The method of Claim 1 wherein the first integrated circuit structure is an interposer that comprises no semiconductor circuit elements in the semiconductor substrate.

20 14. The method of Claim 1 wherein the first integrated circuit structure comprises a semiconductor circuit element in the semiconductor substrate.

15. The method of Claim 1 wherein each first contact pad of the first substrate covers a bottom and sidewalls of the corresponding via.

16. The method of Claim 1 further comprising:

(4) obtaining a second integrated circuit structure comprising:

25 a semiconductor substrate;

one or more first conductive contact pads protruding out at a surface of the second integrated circuit structure;

wherein the first integrated circuit structure further comprises one or more second conductive contact pads, wherein at least a portion of each of the one or more second contact pads of the first integrated circuit structure is located in a corresponding via in a surface of the first integrated circuit structure;

5            wherein the method further comprises:

(5) inserting the protruding first contact pads of the second integrated circuit structure into the corresponding vias of the first integrated circuit structure and attaching the protruding first contact pads of the second integrated circuit structure to the second contact pads of the first integrated circuit structure.

10            17.     The method of Claim 1 wherein the first contact pads of the first integrated circuit structure are located on a first side of the first integrated circuit structure, and the second contact pads of the first integrated circuit structure are located on a second side of the first integrated circuit structure, the first side being opposite to the first side.

15            18.     The method of Claim 1 wherein each first contact pad of the first integrated circuit structure is provided by a conductor formed in a corresponding through via in the semiconductor substrate and protruding out of the through via.

19.     The method of Claim 18 wherein the first contact pads of the first integrated circuit structure protrude out at the surface which is opposite to an active surface of the first integrated circuit structure.

20            20.     A structure comprising:     /

(1) a first integrated circuit structure comprising:

a semiconductor substrate;

one or more first conductive contact pads protruding out at a surface of the first integrated circuit structure;

25            (2) a first substrate comprising a circuit which comprises one or more first conductive contact pads, wherein at least a portion of each of the one or more first contact pads of the first substrate is located in a corresponding via in a surface of the first substrate;

wherein the protruding first contact pads of the first integrated circuit structure are inserted into the corresponding vias of the first substrate and attached to the first contact pads of the first substrate;

5 wherein each first contact pad of the first integrated circuit structure has a non-solder portion inside the corresponding via.

21. The structure of Claim 20 wherein the first contact pads of the first integrated circuit structure are attached to the first contact pads of the first substrate with solder.

10 22. The structure of Claim 20 wherein the first contact pads of the first integrated circuit structure are attached to the first contact pads of the first substrate without solder with thermal or thermosonic compression.

23. The structure of Claim 20 wherein the non-solder portions of the protruding first contact pads of the first integrated circuit structure are made of copper and/or gold and/or nickel.

15 24. The structure of Claim 20 wherein the first substrate comprises a semiconductor substrate.

25. The structure of Claim 20 wherein the first substrate is an integrated circuit packaging substrate which does not comprise a semiconductor substrate.

20 26. The structure of Claim 20 wherein the first substrate is a printed circuit board.

27. The structure of Claim 20 wherein a spacing between the bottom surface of the semiconductor substrate and the top surface of the first substrate is at least 5 $\mu$ m.

25 28. The structure of Claim 20 wherein at least a portion of the bottom surface of the semiconductor substrate is not covered by any dielectric layer in the first integrated circuit structure.

29. The structure of Claim 20 wherein at least a portion of the bottom surface of the semiconductor substrate is covered by a dielectric in the first integrated circuit structure.

30. The structure of Claim 20 wherein at least 10 $\mu$ m of each protruding first contact pad is inside the corresponding via.

31. The structure of Claim 20 wherein the first integrated circuit structure is an interposer that comprises no transistors and no diodes.

5 32. The structure of Claim 20 wherein the first integrated circuit structure comprises a transistor or a diode, the transistor or the diode having a semiconductor region in the semiconductor substrate.

33. The structure of Claim 20 wherein each first contact pad of the first substrate covers a bottom and sidewalls of the corresponding via.

10 34. The structure of Claim 20 further comprising:

(4) a second integrated circuit structure comprising:

a semiconductor substrate;

one or more first conductive contact pads protruding out at a surface of the second integrated circuit structure;

15 wherein the first integrated circuit structure further comprises one or more second conductive contact pads, wherein at least a portion of each of the one or more second contact pads of the first integrated circuit structure is located in a corresponding via in a surface of the first integrated circuit structure;

20 wherein the protruding first contact pads of the second integrated circuit structure are inserted into the corresponding vias of the first integrated circuit structure and attached to the second contact pads of the first integrated circuit structure;

wherein each first contact pad of the second integrated circuit structure has a non-solder portion inside the corresponding via of the first integrated circuit structure.

25 35. The structure of Claim 20 wherein the first contact pads of the first integrated circuit structure are located on a first side of the first integrated circuit structure, and the second contact pads of the first integrated circuit structure are located on a second side of the first integrated circuit structure, the first side being opposite to the first side.

36. The structure of Claim 20 wherein each first contact pad of the first integrated circuit structure is provided by a conductor formed in a corresponding through via in the semiconductor substrate and protruding out of the through via.

37. The structure of Claim 36 wherein the first contact pads of the first integrated circuit structure protrude out at the surface which is opposite to an active surface of the first integrated circuit structure.

38. A first substrate comprising: /

one or more conductive contact pads for attachment to circuitry; and

a dielectric having one or more openings over the one or more contact pads;

10 wherein a surface of at least one of the openings has a first portion which is a surface portion of one of the contact pads, and a second portion made from a different material than the first portion.

39. The first substrate of Claim 38 wherein the second portion of the bottom of said one of the openings is less solder wettable than the first portion.

15 40. The first substrate of Claim 38 wherein the second portion is dielectric.

41. The first substrate of Claim 38 in combination with solder at least on the first portion.

42. The first substrate of Claim 38 in combination with a second substrate having a contact pad soldered to said one of the contact pads of the first substrate with  
20 solder on the first portion.

43. The combination of Claim 42 wherein the second substrate is a semiconductor integrated circuit.

44. The first substrate of Claim 38 wherein the first substrate is a semiconductor integrated circuit packaging substrate that does not include a  
25 semiconductor substrate.

45. The first substrate of Claim 38 wherein the first substrate is a semiconductor integrated circuit.

46. A manufacturing method comprising forming one or more conductive /  
contact pads in a first substrate, and forming dielectric over the one or more contact pads,  
with the dielectric having one or more openings which overlie the contact pads and also  
overlie one or more regions adjacent to the contact pads.
- 5            47. The method of Claim 46 wherein the regions adjacent to the contact pads  
are less solder wettable than the contact pads.
48. The method of Claim 46 wherein the regions adjacent to the contact pads  
are dielectric regions.
49. The method of Claim 46 further comprising:
- 10           placing solder paste into the one or more openings; and  
  
              heating the solder paste to melt the solder.
50. The method of Claim 49 further comprising soldering one or more contact  
pads of a second substrate to the one or more contact pads of the first substrate with  
solder obtained from the solder paste.
- 15           51. The method of Claim 50 wherein the second substrate is a semiconductor  
integrated circuit.
52. The method of Claim 46 wherein the first substrate is a semiconductor  
integrated circuit.
53. The method of Claim 46 wherein the first substrate is an integrated circuit  
20           packaging substrate which does not include a semiconductor substrate.